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Intergenerational income mobility and health in Japan: A quasi-experimental approach

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Abstract

Studies across Europe and the US report that childhood socioeconomic disadvantage is associated with poorer health in adulthood. By contrast, a study in Japan suggests that childhood socioeconomic disadvantage may be positive for adult health. In this paper, we assess the association between intergenerational income mobility and self-rated health in Japan, using detailed childhood income data for 1610 men and 1885 women aged 30–49 years. We use an instrumental variable approach to identify the causal effect of upward income mobility on adult health. We find that low father's income during childhood is associated with smoking and alcohol consumption in adult life for both men and women. For men, upward income mobility was associated with worse health. Certain behavioural choices related to income mobility, such as long working hours, may have detrimental health effects.

Keywords: Intergenerational income mobility, socioeconomic position, childhood, adulthood, health, life-course

Introduction

The association between childhood socioeconomic circumstances and adult health has been extensively examined for high-income countries (Claussen et al., 2003; Galobardes et al., 2008; Kestila et al., 2009; Khang, 2006; Kuh et al., 2002; Lawlor et al., 2002; Marin et al., 2008; McKenzie et al., 2011; Mishra et al., 2013; Parsons et al., 1999; Poulton et al., 2002; Power et al., 2007; Power et al., 2005; Senese et al., 2009; Singh-Manoux et al., 2004; Tani et al., 2016; Tiffin et al., 2005; Tiikkaja et al., 2009; Turrell et al., 2007; Atheendar S. Venkataramani et al., 2016a; A. S. Venkataramani et al., 2016b). Most of these studies conclude that, independently of the attained socioeconomic status in adulthood, poor childhood socioeconomic circumstances and/or downward mobility are associated with poorer health in adult life (Claussen et al., 2003; Galobardes et al., 2008; Kestila et al., 2009; Khang, 2006; Kuh et al., 2002; Lawlor et al., 2002; Marin et al., 2008; McKenzie et al., 2011; Mishra et al., 2013; Parsons et al., 1999; Poulton et al., 2002; Power et al., 2007; Senese et al., 2009; Singh-Manoux et al., 2004; Tiffin et al., 2005; Tiikkaja et al., 2009; Turrell et al., 2007; Atheendar S. Venkataramani et al., 2016a; A. S. Venkataramani et al., 2016b; Yan et al., 2018). Several mechanisms have been proposed to explain this association. In particular, poor early life experiences beginning in utero may affect health due to increased exposure to poor nutrition and toxins (such as maternal cigarette smoking and infectious disease agents) during critical periods of development. On the other hand, socioeconomic disadvantage at each life stage may equally affect health as a consequence of the accumulation of adverse experiences (Barker, 1998; Ben-Shlomo & Kuh, 2002; Gluckman et al., 2008; Singh-Manoux et al., 2004; Turrell et al., 2007). In addition, the early family environment may influence future behavioural choices such as smoking and a poor diet (Kestila et al., 2009; McKenzie et al., 2011;

Parsons et al., 1999; Power et al., 2005). However, the evidence suggests that these associations may not hold in Japan, a country with a distinctive pattern of social mobility relative to other Western countries. In (Ishida, 2001), the author points out that compared to Western countries, the Japanese mobility pattern has distinctive absolute mobility rates but similar relative mobility rates.

Evidence from earlier studies in Japan suggests that, contrary to the findings for western countries, childhood socioeconomic disadvantage may be associated with lower mortality among older men. (Tani et al., 2016) The authors interpret this paradoxical result in several ways: selective survival, preventive effects of childhood physical training, and the effect of post-war calorie restrictions on chronic diseases.

Some studies have also investigated the association between mobility in socioeconomic position, (i.e., whether individuals experience upward or downward mobility compared to their previous status) and health (Bartley & Plewis, 1997; Brody et al., 2013; Hart et al., 1998; James, 1994; Marin et al., 2008; Tiffin et al., 2005). The findings on the health consequences of upward mobility are controversial, however. Upward mobility can improve health by helping escape adverse conditions (Bartley & Plewis, 1997; Hart et al., 1998; Tiffin et al., 2005) but it may also deteriorate health (Brody et al., 2013; James, 1994; Marin et al., 2008). In particular, the latter case may occur since those from the lower socioeconomic status (SES) may have difficulties in adapting themselves to the higher SES or may experience hardship in achieving upward mobility (Berkman et al., 2015).

This study examines the association between intergenerational income mobility and health in a sample of Japanese adults. We address two limitations in the existing literature.

First, previous studies have examined socioeconomic position (SEP) in childhood and adulthood mostly in terms of occupation (Bartley & Plewis, 1997; Blane et al., 1999; Blane et al., 1996; Hart et al., 1998; Khang, 2006; Kuh et al., 2002; Lawlor et al., 2002; McKenzie et al., 2011; Mishra et al., 2013; Poulton et al., 2002; Power et al., 2007; Power et al., 2005; Tiffin et al., 2005; Tiikkaja et al., 2009; Turrell et al., 2007), education (Kestila et al., 2009; Khang, 2006; Tiffin et al., 2005), housing (Claussen et al., 2003; Marin et al., 2008), county-level economic opportunities (Atheendar S. Venkataramani et al., 2016a; A. S. Venkataramani et al., 2016b), and retrospectively in terms of subjective family conditions (Singh-Manoux et al., 2004; Tani et al., 2016; Yan et al., 2018). However, few studies have examined the association between intergenerational income mobility and health. This is an important issue because earlier studies suggest that the results of intergenerational mobility analyses vary according to whether the assessment is conducted using occupation or income (Blanden et al., 2013; Erikson & Goldthorpe, 2010). Furthermore, the literature suggests that income is more strongly and robustly associated with health than other measures of socioeconomic status such as education and occupation (Darin-Mattsson et al., 2017). Therefore, it is important to rethink how intergenerational mobility is measured in the study of its effects on health as also noted in Simandan (2018). To address this issue, we obtain children's income from their fathers' income, estimated by combining two different datasets and creating a pseudo-cohort of fathers and children.

Second, most studies on income mobility and health suffer from potential selection bias: upward socioeconomic mobility is likely to be associated with many characteristics potentially affect adult health, such as early childhood health, parental characteristics, or genetic endowment. We address selection bias by using an instrumental variable approach to identify the effect of income mobility on health.

Methods

Data

The dataset is built from two repeated nationwide cross-sectional surveys conducted in Japan: the National Survey of Social Stratification and Social Mobility (SSM) and the Japanese General Social Surveys (JGSS). The SSM comprises an interview and a self-administered questionnaire survey targeting individuals aged 20–69 years extracted by stratified two-stage random sampling, and was conducted in 1965, 1975, 1985, 1995, and 2005. The JGSS is directed at people aged 20–89 years and was undertaken in 2000, 2001, 2002, 2003, 2005, 2006, 2008, 2010, and 2012. Response rates for each survey ranged from 44.1% to 71.9% (details are provided in Appendix Tables A1, A2). As for JGSS, it has been reported that the response rates in urban areas are likely to be low (Hanibuchi et al., 2012). Nevertheless, evidence of non-response biases was not observed after controlling via multivariate analyses (Rindfuss et al., 2015). The final sample included 1,694 men and 1,966 women aged 30–49 years.

Health measure

We use the self-rated health (SRH) scale as our measure of overall health. Although this measure has limitations, it is nevertheless correlated with mortality and morbidity (Chandola & Jenkinson, 2000; DeSalvo et al., 2006; Heistaro et al., 2001; Idler & Benyamini, 1997). Respondents were asked to assess their SRH on a five-point Likert scale from 1 (bad) to 5 (good). We create a binary variable based on the SRH scale that takes the value one if respondents report their health as bad (1) or somewhat bad (2). In addition to the SRH scale, to test the effect of father's income on health behaviours, we use smoking and alcohol consumption as indicators of health behaviours. Smoking is assessed by whether a respondent currently smoke or not. Alcohol consumption is given in frequency terms: None, less than once a week, a few times a week, and almost every day.

Imputation of Father's Income Using a Pseudo-cohort Approach

Neither the SSM nor the JGSS include an item related to fathers' income, but information about education and occupation is available. Following the approach by Sato and Yoshida (2007), we create a 'pseudo-cohort' of fathers and children by obtaining the income function from the SSM and applying it to participants in the JGSS. The analysis is restricted to men and women aged 30–49 years for the JGSS sample (2000–2012). The data for estimating the income function is collected from the SSM for the years 1965–2005 and are related to the period when the respondents were aged 15 years. The JGSS contains questions about the father's educational attainment and occupation when the respondent was aged 15 years. Thus, the respondents aged 30–49 years with each survey of JGSS were aged 15 years between 1966 and 1997. To estimate the income function, we pooled SSM samples for 1965, 1975, 1985, 1995, and 2005 (only men aged 59 years or younger) to cover all periods of from 1966 to 1997.

The second step consists in obtaining the individual gross income of the male participants at each SSM survey year and adjusting it according to the consumer price index (2015 = 100). To deal with outliers, individuals in the upper and lower 2.5% tails of each survey were excluded after eliminating those without income (n=240). The final data consists of 8,898 SSM respondents. The income function is estimated by ordinary least-squares regression, using survey year, age, square of age, educational attainment, employment status, occupation, and scale of workplace as independent variables.

To minimise potential prediction errors by model misspecification, we utilise machine learning methods as follows:

i) Perform variable selections based on the Furnival-Wilson leaps-and-bounds algorithm (Furnival & Wilson, 1974), and then select the model with the smallest Akaike Information Criterion.

ii) Perform cross-validation (k-fold cross validation with k=10) for model selection (Arlot & Celisse, 2010), and choose the model with the smallest average root mean square error, namely, ordinary least squares, support vector regression, or random forest algorithm.

The result of the k-fold cross validation is shown in Table 1. Consequently, the estimation formalised by Equation (1) below is performed by the ordinary least squares, and the result is shown in Table 2:

$$\ln(Income) = \beta_0 + \beta_1 \mathrm{Year} + \beta_2 \mathrm{Age} + \beta_3 \mathrm{Age}^2 + \beta_4 \mathrm{Education} + \beta_5 \mathrm{Employment\ status} + \beta_6 \mathrm{Occupation} + \beta_7 \mathrm{Scale\ of\ workplace} \quad (1)$$

Next, fathers' income among JGSS respondents is determined by applying the income function to the corresponding father information when the respondents were aged 15 years. Because the JGSS has no information on father's age, we impute father's age based on data from the national demographic survey, assigning 15 years to the average age of fathers when they had a child for each survey year in the national demographic survey (Ministry of Health, Labour and Welfare). To analyse fathers' income in the JGSS, the coefficients of year dummies of the SSM are used for multiple years (e.g. the coefficient for 1975 was used if the respondent was aged 15 years between 1971 and

1979). Adult income and gross individual income from work are based on participant self-reports and is adjusted according to the consumer price index (2015 = 100).

Furthermore, income *z* scores for both respondents and their fathers are adjusted for the effects of age. Income classes are determined by dividing the obtained *z* scores into quartiles. Regarding women's income, the husband's income was used if they were married: following marriage, it is not rare in Japan for women to leave their jobs and become homemakers or engage in part-time work only. Individuals in the upper and lower 2.5% tails of each edition of the JGSS were excluded after eliminating those without income (n=254) to exclude outliers from the analysis.

Intergenerational income mobility is measured through interaction terms between childhood and adult income quartiles: lower, lower-middle, upper-middle, and upper.

Other independent variables

To control for confounders, we incorporate information on age, occupation, marital status, and cohort dummy variables. Occupation is divided into nine categories: professional; management; clerical; sales; agricultural; skilled; semi-skilled; non-skilled; and homemaker (women only). Marital status was based on a scale with three categories: married, not married, or experienced bereavement and divorce. Cohort dummy variables were defined as follows: be born between 1950-1954, 1955-1959, 1960-1964, 1965-1969, 1970-1974, 1975-1979, and 1980-1984. Finally, we controlled for whether the participant was living in an area where the population was over 200,000 (Eberhardt & Pamuk, 2004). Individuals lacking information on any of these variables were excluded from the analysis (n=3,967).

Estimation and Identification Strategy

To determine the effect of father's and adult income on SRH/health behaviour, we first conduct a gender-specific logistic regression analysis. We start by estimating the association of father's and adult income with health/health behaviour. Subsequently, we estimate the association between adult income and health/health behaviour for the different father's income groups. We then examine the association between income mobility and health by implementing the following model:

$$SRH_i = \alpha + \beta Upward_i + \gamma X_i + u_i, \quad (2)$$

where SRH_i is a binary variable denoting poor health for individual i. The variable $Upward_i$ stands for intergenerational income mobility, which takes a value of one if a respondent experienced upward mobility and 0 if the individual experienced downward mobility or remained in the same income group. X_i denotes a vector of control variables including age, occupation, marital status, living in an area with a population of over 200,000, and a cohort dummy.

A potential concern at this stage is that social mobility may not be exogenous: socioeconomic status and health are jointly and endogenously determined in a process often referred to as "social causation" or "health selection" (Chandola et al., 2003; Foverskov & Holm, 2016). Earlier studies typically address this bias by controlling for observables. However, information about childhood experiences is often limited, likely resulting in unmeasured confounding or omitted variable bias. To approach a causal interpretation, we implement an instrumental variable (IV) model that exploits potentially exogenous variation in social mobility. We therefore estimate a Two-Stage least squares (2SLS) model whose first stage is based on the following equation:

$$Upward_i = \delta + \eta \ln(Advancement\ Rate\ of\ University_i) +$$

$$\zeta Rural\ Residents\ in\ Childhood_i + \theta X_i + e_i, \quad (3)$$

where $Advancement\ Rate\ of\ University_i$ denotes the advancement rate for university/junior college in Japan when the respondent was aged 18 years. $Rural\ Residents\ in\ Childhood_i$ denotes whether a respondent lived in a rural area when they were 15 years of age. For the second stage of the 2SLS model, we use the predicted value of upward income mobility obtained from Equation 3. We use this instrument to capture changes in social mobility generated by changes in the rate of access to higher education and living in a rural area during childhood. Our assumption is that educational attainment is an important factor in determining income distribution and should affect the probability of income mobility, while having no direct effect on health other than by influencing income (De Gregorio & Lee, 2002). Living in a rural area may be associated with education and job opportunities as it may be easier for children to earn more than their fathers by finding better prospects by moving to an urban area (Ito, 2006). University advancement rates may be influenced by various factors, such as the value of higher education in the labour market, educational policies, and subsidies for education (including scholarships). These factors are usually exogenous to individuals. If there are greater chances to obtain a higher education, intergenerational income mobility is more likely to occur—irrespective of socioeconomic position. Macro changes in education by themselves do not affect individual health directly but can affect the likelihood of an individual's ability to increase his or her income. As an example, even if the university advancement rate increases due to more scholarship availability, a person does not receive the benefits from higher education when he or she does not enrol. Thus, we assume that macro changes in education do not affect individual health directly. Directly measuring changes in educational policy or increases in educational subsidies would be more desirable; however, we were unable to find an appropriate instrument that allowed sufficient variation by cohort. Thus, caution is necessary when interpreting the results obtained using an instrumental variable approach.

As for residence during childhood, the place of residence is likely to have an effect on health via socioeconomic and demographic factors as well as health care access (Eberhardt & Pamuk, 2004). Therefore, we also assume that rural residency during childhood does not affect health directly as well.

As the university advancement rate is likely to increase overall as the society becomes more industrialised, other factors such as technology and knowledge about health care could show a similar trend. We address this problem by including age and cohort dummies into our models. All the analysis is performed in Stata, version 15.1.

Results

Table 3 shows father's and adult income for men and women separately. For both men and women, the proportion of those in the lower-income segment during childhood is the largest (30.2% and 29.3%, respectively).

On the other hand, during adulthood, the proportion of men with upper-middle income and women with upper income are the corresponding majorities (26.7% and 26.9%, respectively).

Table 4 shows descriptive statistics of SRH, income measures and other variables included in the models. Around 14% of men/women report their health as being bad. Smoking rates of men is 47.8% while that of women is 16.7%. As for alcohol consumption, 9.0% of men and 24.6% of women do not drink alcohol at all while 36.8% of men and 22.0% of women report that they drink almost every day. Smoking rates for individuals aged between 30 and 49 years in 2012 are a little higher than the national statistics at approximately 43% and 12% for men and women respectively (Ministry of Health, Labour and Welfare). However, alcohol consumption is not comparable due to the differences in its measurement between the public statistics and the JGSS. About 30% of women are not in labour market as they are principally engaged in homemaking.

Tables 5 and 6 show the estimation results for the association of SRH/health behaviour with childhood and adult income. Fully adjusted results shown in Table 6 indicate that, for men, lower father's income is associated with a higher probability of smoking and alcohol consumption compared to higher father's income quantiles (for smoking, odds ratio [OR]: 1.61, 95% confidence interval [CI]: 1.20-2.15; for alcohol, OR: 1.38, 95%, CI: 1.06-1.79). For women, low father's income is associated with worse health relative to those in the highest income quartile (lowest quartile, OR: 2.20, 95%, CI: 1.41–3.41; lower-middle, OR: 1.71, 95% CI: 1.08-2.70; upper-middle, OR: 1.94, 95% CI: 1.24–3.06). Higher probabilities of smoking were also observed for women with low father's income (lower, OR: 1.84, 95% CI: 1.25-2.70; lower-middle, OR: 1.98, 95% CI: 1.35-2.90). In addition, women tend to smoke more when their adult income is in the lowest quartile (OR: 1.64, 95%, CI: 1.11-2.43) while alcohol consumption displays the opposite trend (lower, OR: 0.71, 95% CI: 0.55-0.93; lower-middle, OR: 0.68, 95% CI: 0.53-0.87). The four panels in Figures 1 and 2 show the association between adult income and SRH/health behaviour for men and women separately. The figures also display information about childhood income by quartiles. For men, there is no clear adult income gradient in SRH for any of the childhood income categories while upper adult income in combination with lower-middle father's income was associated with the highest frequency of alcohol drinking. By contrast, for women, the association between adult income and SRH was strongest for those who had lower income during childhood, while there was a less clear gradient for the other groups.

Estimation Results by Instrumental Variables Approach

Table 7 reports the first-stage analysis of the relationship between university advancement rates and upward mobility. University advancement rates are strong predictors of intergenerational income mobility only for men. A one-percentage point increase in the university advancement rate is associated with a 0.54% decrease in upward mobility for men, while rural residency during childhood is associated with a 0.11% increase in upward mobility.

Table 8 shows the coefficients of the second-stage model on the effect of upward mobility on SRH. Our tests indicate that endogeneity is problematic for men (Durbin-Wu-Hausman endogeneity test, $P < 0.01$). Among men, those who experience upward income mobility are associated with a 40% increase in probability of reporting poor health. By contrast, among women, the identification strategy was not successful and there is no association between upward mobility and SRH.

Robustness checks

We perform several checks to assess the robustness of the results. The tables for the results are shown in the Appendix.

First, we refine the analysis by considering deciles of father's and adult income as opposed to quartiles. Tables A3 and A4 show the results of the first and second stage analyses.

Second, ordered probit models are estimated to make predictions with ordered

SRH outcomes on a scale of 1 (bad) to 5 (good). Table A5 shows the results of the second stage analysis in this case.

Both robustness checks confirm the results obtained earlier: upward mobility for men deteriorates health while for women the weak identification problem leads to unreliable results.

Discussion

The main purpose of this study is to investigate the relationship between intergenerational income mobility and health/health behaviour using a sample of Japanese men and women in mid-adulthood. We observe that the lowest father's income is associated with an increased probability of cigarette smoking for both men and women, with more frequent alcohol consumption for men and worse SRH for women. For women, there is a link between low adult income and worse SRH as well as an increase in the likelihood of smoking. In addition, our main contribution to the literature is to show that, once accounting for endogenous selection, upward income mobility is associated with worse SRH for men.

While a study with Japanese respondents may report different results than the Western studies conducted so far (Tani et al., 2016), due to factors such as distinctive patterns of social mobility (Ishida, 2001), our study nevertheless suggests that adverse childhood economic circumstances as measured by father's income are associated with worse health/health behavioural choices, thus confirming the results of previous studies (Bartley & Plewis, 1997; Blane et al., 1996; Claussen et al., 2003; Galobardes et al., 2004; Galobardes et al., 2008; Hart et al., 1998; Kestila et al., 2009; Khang, 2006; Kuh et al., 2002; Lawlor et al., 2002; Marin et al., 2008; McKenzie et al., 2011; Mishra et al., 2013;

Parsons et al., 1999; Poulton et al., 2002; Power et al., 2007; Power et al., 2005; Senese et al., 2009; Singh-Manoux et al., 2004; Tiffin et al., 2005; Tiikkaja et al., 2009; Turrell et al., 2007; Atheendar S. Venkataramani et al., 2016a; A. S. Venkataramani et al., 2016b). Furthermore, our findings regarding income mobility and health support the hypothesis that upward mobility deteriorates health, confirming the results of previous work (Brody et al., 2013; James, 1994; Marin et al., 2008).

As described earlier, there are a number of mechanisms guiding the relationship between childhood socioeconomic circumstances and adult health. First, childhood socioeconomic disadvantage affects adult health due to the accumulation of disease risks (Singh-Manoux et al., 2004) and exposure to health risks during critical periods of development (Ben-Shlomo & Kuh, 2002). Second, childhood circumstances may partly contribute to the certain patterns of health behaviour, such as smoking. (Kestila et al., 2009; McKenzie et al., 2011; Parsons et al., 1999; Power et al., 2005)

Systematic reviews suggest that there is an association between socioeconomic disadvantages during childhood and increased risk for coronary heart disease, strokes, and all-cause mortality (Galobardes et al., 2004; Galobardes et al., 2008). This is partly because childhood income is inversely related to adulthood obesity.(Parsons et al., 1999; Senese et al., 2009) However, this finding may not apply to Japan, which has the lowest prevalence of obesity across OECD nations.(OECD, 2017)

From the results of the analysis of income mobility, we find that upward mobility deteriorated SRH for men. This result is consistent with previous studies (Brody et al., 2013; James, 1994; Marin et al., 2008). Further research is necessary to confirm and/or generalize our results. However, achieving upward mobility and higher earnings in adulthood can by itself be stressful, leading to a form of 'John Henryism' (Berkman et al., 2015; James, 1994). In fact, it has been pointed out that individuals in higher positions (e.g. managers) are likely to work longer hours (Ogura, 2009) while the prevalence of long working hours (defined as those who work for 49 hours or more per week) among Japanese men is around 30%, compared to levels below 20% in Western countries such as the UK and France (The Japan Institute for Labour Policy and Training). Earlier studies, moreover, suggest that there is an association between long working hours and poor health (Dembe et al., 2005; Kivimäki et al., 2015; van der Hulst, 2003). This perspective is consistent with human capital theory, namely the Grossman model, which predicts that more time spent at work will decrease the time available for health investments (Grossman, 1972). Furthermore, previous literature notes that Japanese workers are required to work long hours to be promoted in the traditional Japanese-style work environment as hours of work, length of service (as a measure of commitment), and employer loyalty tend to be more important that output when employees are assessed. (Ono, 2016). Therefore, 'John Henryism' is likely to apply to the Japanese in the context of social mobility.

The above remarks demand further investigation, namely, observing what happens to those who experience mobility. However, the effects of intergenerational mobility on health (especially for men, who are usually heads of household in Japan) can vary by country and cohort (OECD, 2008; Yamada et al., 2014). In addition, the effects of such mobility on health can differ owing to the historical or technological context (e.g., war, nutrition status, and availability of health-care technologies) as pointed out in Tani et al. (2016).

In this study, we observe different results for men and women, but this finding needs careful interpretation since a sizeable proportion of women (30.88%) left the labour market to concentrate on homemaking. Furthermore, even if married women are in the labour market, they tend to work part-time on lower income jobs since tax deductions and social insurance for spouses is provided only for those with annual income lower than 1.03 million JPY. This is why we attempt to capture the SES of married adult women by using the husband's income, although we understand that this method has its limitations.

There are limitations in our work that should be addressed by future research. First, the available information about health conditions was only self-reported. While we approached the issue of limited health information by analysing health behaviours instead, further work is required to explore disease-specific outcomes in more detail not only for the prevention of diseases associated with social mobility and childhood socioeconomic disadvantages, but also to better understand the health consequences of social mobility. Second, our analysis is based on cross-sectional data only for subjects in mid-adulthood, and our sample was relatively small. For this reason, we could not consider intertemporal differences (especially in health) for the same person. We were also unable to assess time-invariant unobserved factors that may affect health such as genetics. Furthermore, although previous work reports that non-response biases are controllable (Rindfuss et al., 2015), it is still possible that those with severe health and socioeconomic conditions are not included in the samples. Challenges lie in designing studies without potential non-response biases, reflecting the genuine income distribution (Ravallion, 2016). Future sample studies should also improve response collection techniques by minimising potential unsystematic biases. It is also necessary to develop better instrumental variables to gain new insights about the causal relationship between intergenerational mobility and health. We were unable to use more direct, exogenous variables to capture the environment for education, such as educational policies and subsidies. As a consequence, university enrolment could be endogenous: people may become more likely to enter higher education owing to better socioeconomic and public health conditions even though one study in Japan found that an increase in university enrolment rate was explained mostly by supply factors (e.g. number of universities) and not by economic conditions (Ushiogi, 2008). Thus, the results of our instrumental variable models must be interpreted with great care. Third, as discussed earlier, the SES measurement for married women can be limited since we use the husband's income. This might explain differences in results for men and women as this method may only provide a rough measure of the SES of married women. Further work is required to determine if our procedure over- or underestimates the SES of married women.

In conclusion, our findings suggest that childhood SES is associated with the behavioural choices leading to poor health for both men and women. For men, we find that upward income mobility is associated with worse health, and this association does not seem to be driven by selection bias. Longitudinal studies following individuals for decades are required to confirm these results and to understand the reasons behind the potentially different patterns of social mobility in Japan relative to Western countries.

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Tables

Table 1. Results of k-fold cross validation

	Root mean square error		
	OLS	Random forest	Support vector
Estimation 1	0.590071	0.628020	0.645695
Estimation 2	0.577907	0.616014	0.678228
Estimation 3	0.536288	0.624597	0.644789
Estimation 4	0.554865	0.622640	0.641780
Estimation 5	0.576280	0.647174	0.656343
Estimation 6	0.570058	0.648540	0.656779
Estimation 7	0.596973	0.633991	0.617439
Estimation 8	0.593829	0.663734	0.679876
Estimation 9	0.569711	0.657486	0.657488
Estimation 10	0.607362	0.625614	0.655625
Average	0.577334	0.636781	0.653404

Table 2. Estimation of income function by SSM

Year		Education		Age	
year_1975	0.42** [a]	High School	0.14**	age	0.10**
	(0.38 - 0.46)		(0.11 - 0.18)		(0.09 - 0.11)
year_1985	0.55**	University	0.18**	age^2	-0.00**
	(0.51 - 0.59)		(0.14 - 0.22)		(-0.00 to -0.00)
year_1995	0.69**	(Ref. Junior)			
	(0.65 - 0.73)				
year_2005	0.48**				
	(0.43 - 0.53)				
(Ref. 1965)					
Status		**Occupation**		**Scale of work place**	
Manager	0.23**	Professional	0.32**	Medium (〜299)	0.07**
	(0.17 - 0.29)		(0.26 - 0.38)		(0.03 - 0.10)
Self-employment	-0.05**	Executive	0.52**	Large/Government (300〜)	0.21**
	(-0.09 to -0.01)		(0.46 - 0.59)		(0.17 - 0.24)
(Ref. Employee)		Clerical	0.32**	(Ref. Small: ~29)	
			(0.26 - 0.38)		
		Sales	0.27**	Constant	2.74**
			(0.21 - 0.32)		(2.56 - 2.92)
		Skilled	0.23**	Observations	8898
			(0.17 - 0.28)	R-squared	0.34
		Semi-skilled	0.25**		
			(0.19 - 0.31)		
		Non-skilled	0.13**		
			(0.05 - 0.21)		
		(Ref. Agriculture)			

a) Numbers are coefficients with 95% confidence intervals in parentheses. ***P* <0.01, * *P* <0.05.

Table 3. Descriptive statistics of father's and adult income [a)]

		Men (n=1726) Proportion	Women (1957) Proportion
Father's income	Lower	30.2%	29.3%
	Lower-middle	25.6%	25.9%
	Upper-middle	23.9%	24.6%
	Upper	20.3%	20.2%
Adult income	Lower	23.2%	24.6%
	Lower-middle	23.9%	24.1%
	Upper-middle	26.7%	24.3%
	Upper	26.2%	26.9%

a) Adult income of women was their own income if they were not married or their husband's income if they were married.

Table 4. Descriptive statics of outcome and independent variables

	Men (n= 1726)		Women (n=1957)	
	mean/ proportion	Standard deviation	mean/ proportion	Standard deviation
Self-rated health (1=bad)	0.14	0.35	0.13	0.34
Current smoker	0.48	0.50	0.170	0.37
Alcohol consumption: None	0.09	0.29	0.25	0.43
Less than once a week	0.34	0.47	0.50	0.50
A few times a week	0.20	0.40	0.15	0.35
Almost everyday	0.37	0.48	0.11	0.31
Father's income: Lower	0.30	0.46	0.29	0.46
Lower-middle	0.26	0.44	0.26	0.44
Upper-middle	0.24	0.43	0.25	0.43
Upper	0.23	0.40	0.20	0.40
Adult income: Lower	0.23	0.42	0.25	0.43
Lower-middle	0.24	0.43	0.24	0.43
Upper-middle	0.27	0.44	0.24	0.44
Upper	0.26	0.44	0.27	0.44
Age	39.58	5.74	39.39	5.71
Marital status: Unmarried	0.10	0.30	0.06	0.23
Divorce/bereavement	0.13	0.33	0.12	0.32
Married	0.78	0.42	0.83	0.38
Occupation: Professional	0.18	0.39	0.17	0.37
Executive	0.02	0.15	0.00	0.05
Clerical	0.27	0.44	0.26	0.44
Sales	0.15	0.35	0.09	0.28
Agriculture	0.02	0.15	0.01	0.11
Skilled	0.18	0.39	0.05	0.21
Semi-skilled	0.18	0.38	0.08	0.28
Non-skilled	0.01	0.07	0.04	0.18
Homemaker			0.31	0.46
Living in a large city	0.35	0.48	0.31	0.46
Cohort: 1950-1954	0.08	0.28	0.08	0.27
1955 - 1959	0.16	0.37	0.16	0.36
1960 - 1964	0.23	0.42	0.23	0.42
1965 - 1969	0.24	0.43	0.25	0.43
1970 - 1974	0.20	0.40	0.20	0.40
1975 - 1979	0.08	0.26	0.09	0.28
1980 - 1984	0.01	0.10	0.01	0.08

Table 5. Father's and adult income and health/behaviour: Model 1 a) b)

Model 1		Men (n=1726)								
		SRH	SRH	SRH	Smoking	Smoking	Smoking	Alcohol	Alcohol	Alcohol
Father's income (Ref. Upper)	Lower	1.36		1.36	2.01**		1.95**	1.43**		1.48**
		(0.90 - 2.05)		(0.90 - 2.06)	(1.52 - 2.65)		(1.48 - 2.58)	(1.12 - 1.84)		(1.15 - 1.90)
	Lower-middle	1.54*		1.55*	1.43*		1.39*	1.07		1.10
		(1.01 - 2.34)		(1.02 - 2.35)	(1.07 - 1.90)		(1.05 - 1.85)	(0.83 - 1.38)		(0.85 - 1.42)
	Upper-middle	1.18		1.18	1.02		1.00	1.18		1.21
		(0.76 - 1.83)		(0.76 - 1.84)	(0.76 - 1.36)		(0.75 - 1.34)	(0.91 - 1.53)		(0.93 - 1.56)
Adult income (Ref. Upper)	Lower		0.87	0.84		1.53**	1.47**		0.71**	0.69**
			(0.59 - 1.27)	(0.57 - 1.24)		(1.17 - 2.01)	(1.12 - 1.93)		(0.56 - 0.91)	(0.54 - 0.89)
	Lower-middle		0.92	0.91		1.23	1.23		0.84	0.82
			(0.63 - 1.33)	(0.62 - 1.32)		(0.94 - 1.60)	(0.94 - 1.61)		(0.66 - 1.07)	(0.65 - 1.05)
	Upper-middle		0.78	0.78		1.12	1.14		0.84	0.84
			(0.54 - 1.13)	(0.54 - 1.14)		(0.86 - 1.46)	(0.88 - 1.49)		(0.67 - 1.07)	(0.66 - 1.06)
		Women (n=1957)								
		SRH	SRH	SRH	Smoking	Smoking	Smoking	Alcohol	Alcohol	Alcohol
Father's income (Ref. Upper)	Lower	2.27**		2.25**	1.80**		1.73**	0.89		0.88
		(1.48 - 3.49)		(1.46 - 3.46)	(1.24 - 2.62)		(1.19 - 2.53)	(0.70 - 1.13)		(0.69 - 1.13)
	Lower-middle	1.73*		1.72*	1.98**		1.94**	1.10		1.09
		(1.10 - 2.71)		(1.09 - 2.69)	(1.36 - 2.88)		(1.33 - 2.83)	(0.86 - 1.40)		(0.85 - 1.40)
	Upper-middle	1.89**		1.91**	1.31		1.31	0.92		0.91
		(1.21 - 2.97)		(1.22 - 2.99)	(0.88 - 1.94)		(0.88 - 1.96)	(0.71 - 1.17)		(0.71 - 1.16)
Adult income (Ref. Upper)	Lower		1.48*	1.44		2.27**	2.20**		0.71*	0.71*
			(1.03 - 2.15)	(1.00 - 2.09)		(1.61 - 3.19)	(1.56 - 3.11)		(0.55 - 0.93)	(0.55 - 0.93)
	Lower-middle		1.36	1.38		1.45*	1.46*		0.69**	0.68**
			(0.93 - 1.98)	(0.94 - 2.01)		(1.01 - 2.09)	(1.02 - 2.10)		(0.54 - 0.87)	(0.53 - 0.87)
	Upper-middle		1.15	1.14		1.51*	1.51*		0.89	0.89
			(0.78 - 1.69)	(0.78 - 1.68)		(1.06 - 2.17)	(1.05 - 2.17)		(0.70 - 1.12)	(0.70 - 1.12)

a) Model 1: Adjusted by age. Full results are available upon request.

b) Numbers are odds ratios with 95% confidence intervals in parentheses. ***P* <0.01, **P* <0.05.

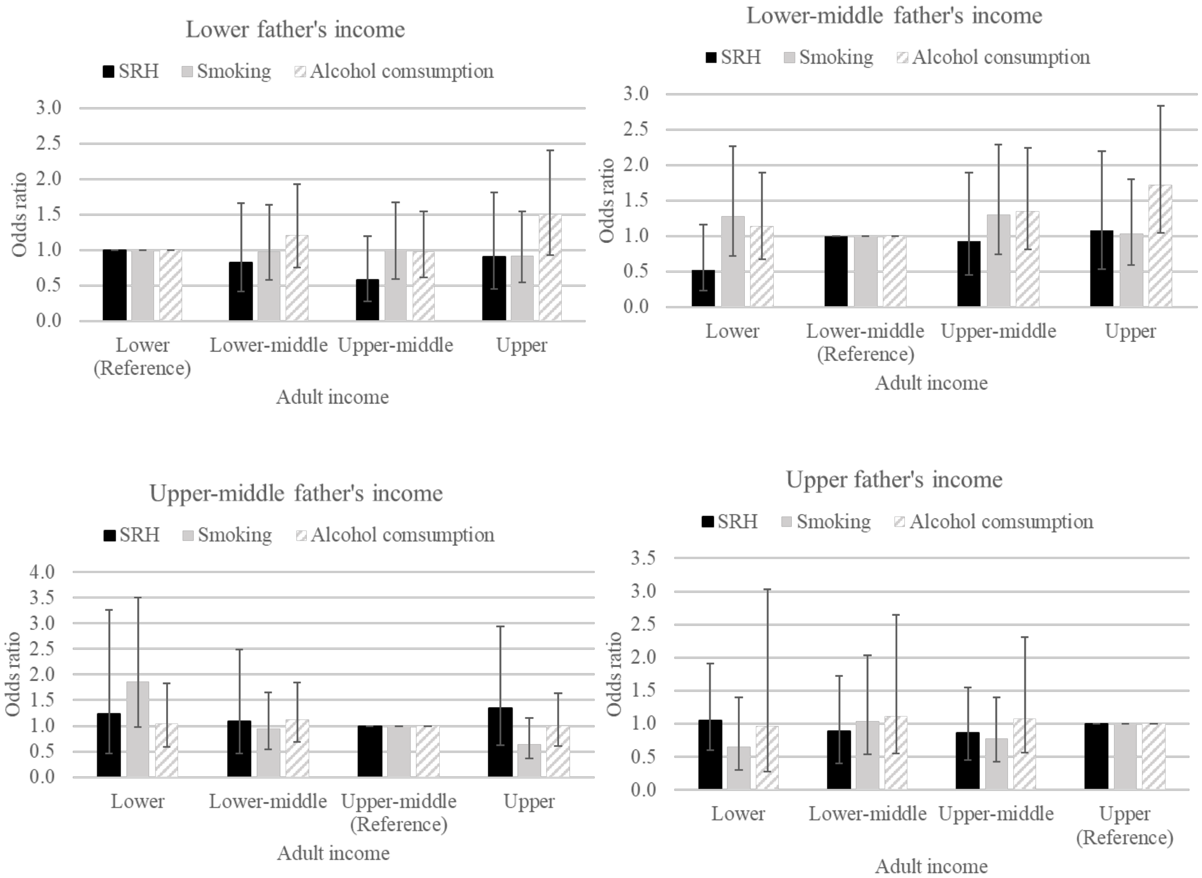
Table 6. Father's and adult income and health/behaviour: Model 2 a) b)

Model 2		Men (n=1726)								
		SRH	SRH	SRH	Smoking	Smoking	Smoking	Alcohol	Alcohol	Alcohol
Father's income (Ref. Upper)	Lower	1.26 (0.82 - 1.93)		1.26 (0.82 - 1.94)	1.62** (1.21 - 2.17)		1.61** (1.20 - 2.15)	1.36* (1.05 - 1.76)		1.38* (1.06 - 1.79)
	Lower-middle	1.47 (0.96 - 2.24)		1.47 (0.96 - 2.24)	1.21 (0.90 - 1.62)		1.20 (0.90 - 1.61)	1.07 (0.83 - 1.39)		1.08 (0.83 - 1.40)
	Upper-middle	1.16 (0.75 - 1.80)		1.17 (0.75 - 1.82)	0.97 (0.72 - 1.30)		0.96 (0.71 - 1.30)	1.19 (0.91 - 1.54)		1.20 (0.93 - 1.56)
Adult income (Ref. Upper)	Lower		0.82 (0.54 - 1.25)	0.81 (0.53 - 1.24)		1.25 (0.92 - 1.69)	1.24 (0.91 - 1.68)		0.82 (0.63 - 1.08)	0.80 (0.61 - 1.06)
	Lower-middle		0.88 (0.60 - 1.30)	0.88 (0.60 - 1.30)		1.06 (0.80 - 1.40)	1.08 (0.81 - 1.43)		0.87 (0.68 - 1.12)	0.86 (0.67 - 1.10)
	Upper-middle		0.77 (0.53 - 1.12)	0.78 (0.53 - 1.13)		1.08 (0.82 - 1.41)	1.10 (0.84 - 1.44)		0.86 (0.68 - 1.09)	0.86 (0.67 - 1.09)
		Women (n=1957)								
		SRH	SRH	SRH	Smoking	Smoking	Smoking	Alcohol	Alcohol	Alcohol
Father's income (Ref. Upper)	Lower	2.25** (1.45 - 3.49)		2.20** (1.41 - 3.41)	1.90** (1.30 - 2.80)		1.84** (1.25 - 2.70)	0.88 (0.69 - 1.12)		0.88 (0.69 - 1.13)
	Lower-middle	1.75* (1.11 - 2.76)		1.71* (1.08 - 2.70)	2.01** (1.37 - 2.95)		1.98** (1.35 - 2.90)	1.08 (0.84 - 1.38)		1.09 (0.85 - 1.40)
	Upper-middle	1.94** (1.23 - 3.05)		1.94** (1.24 - 3.06)	1.36 (0.91 - 2.04)		1.36 (0.91 - 2.04)	0.92 (0.72 - 1.18)		0.91 (0.71 - 1.16)
Adult income (Ref. Upper)	Lower		1.74** (1.15 - 2.63)	1.66* (1.09 - 2.52)		1.74** (1.18 - 2.56)	1.64* (1.11 - 2.43)		0.71* (0.55 - 0.93)	0.71* (0.55 - 0.93)
	Lower-middle		1.58* (1.07 - 2.32)	1.59* (1.07 - 2.34)		1.32 (0.91 - 1.92)	1.31 (0.90 - 1.91)		0.69** (0.54 - 0.87)	0.68** (0.53 - 0.87)
	Upper-middle		1.23 (0.83 - 1.81)	1.21 (0.82 - 1.80)		1.45* (1.00 - 2.08)	1.44 (1.00 - 2.07)		0.89 (0.70 - 1.12)	0.89 (0.70 - 1.12)

a) Model 2: Adjusted by age, occupation, marital status, and scale of residential area. In some analyses, some respondents were omitted due to the small variety in some category. Full results are available upon request.

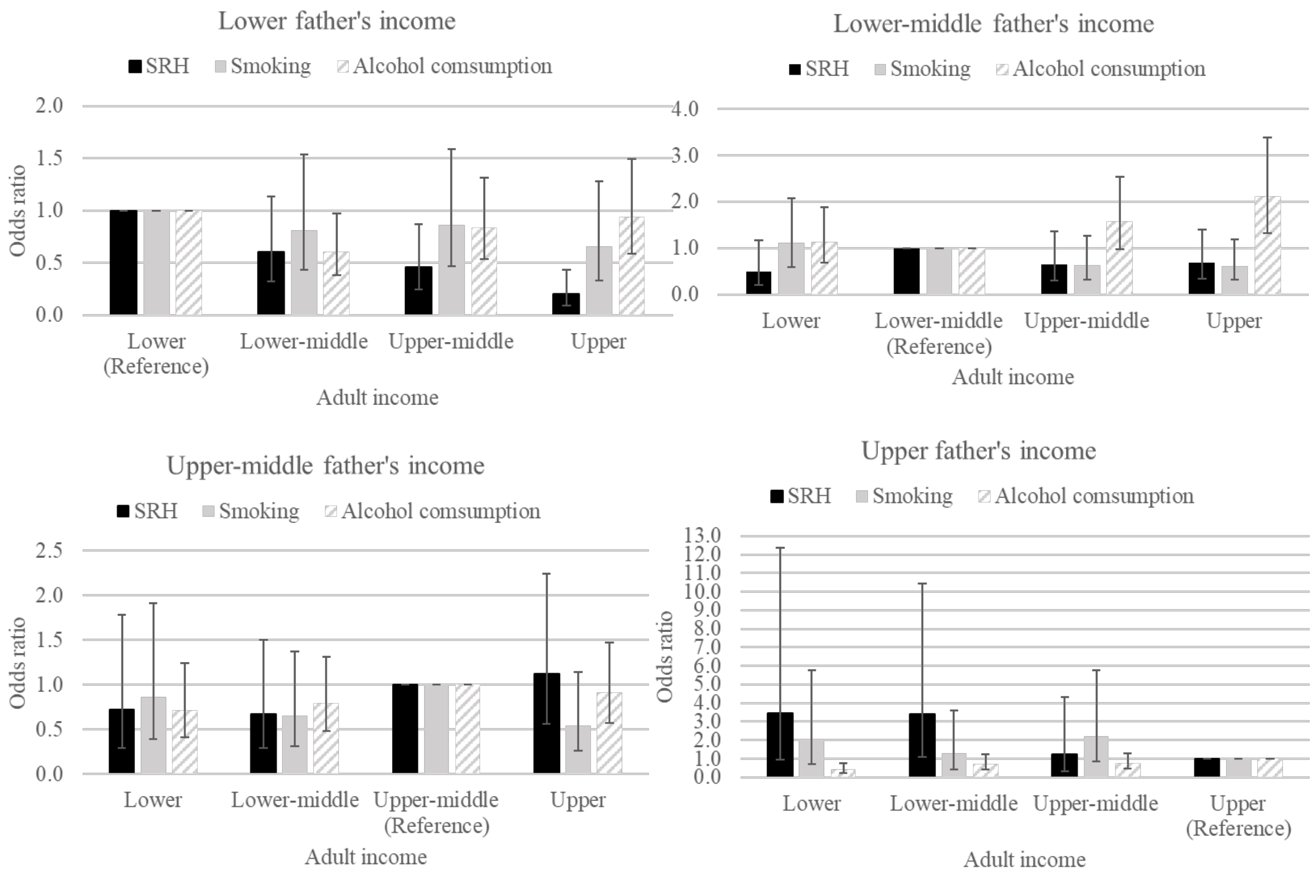
b) Numbers are odds ratios with 95% confidence intervals in parentheses. ***P* <0.01, **P* <0.05.

Figure 1. Associations between health/behaviour and adult income among the same income class of origin for men (n=1726) [a) b)]



a) Adjusted by age, occupation, marital status, and scale of residential area. In some analyses, some respondents were omitted due to the small variety in some category. Full results are available upon request.

Figure 2. Associations between health/behaviour and adult income among the same income class of origin for women (n=1957) a) b)`



a) Adjusted by age, occupation, marital status, and scale of residential area. In some analyses, some respondents were omitted due to the small variety in some category. Full results are available upon request.

Table 7. Results of estimation of first-stage analyses

Endogenous variable: Upward	(1) Men	(2) Women
ln (University advancement rate)	-0.54**	-0.33
	(-0.95 to -0.14)	(-0.72 - 0.06)
Rural resident in childhood	0.11**	0.05*
	(0.06 - 0.16)	(0.00 - 0.09)
Age	-0.03**	-0.03**
	(-0.03 to -0.02)	(-0.04 to -0.02)
Marital status (Ref. Unmarried)		
Divorce/bereavement	-0.06	-0.14**
	(-0.15 - 0.03)	(-0.21 to -0.07)
Married	0.17**	0.25**
	(0.11 - 0.24)	(0.19 - 0.32)
Occupation (Ref. Professional)		
Executive	0.07	-0.19
	(-0.08 - 0.23)	(-0.38 - 0.01)
Clerical	0.01	0.01
	(-0.05 - 0.08)	(-0.05 - 0.07)
Sales	-0.08*	-0.03
	(-0.15 to -0.00)	(-0.11 - 0.05)
Agriculture	-0.01	0.02
	(-0.15 - 0.17)	(-0.20 - 0.24)
Skilled	-0.02	-0.05
	(-0.10 - 0.05)	(-0.16 - 0.05)
Semi-skilled	-0.09**	-0.05
	(-0.16 to -0.01)	(-0.13 - 0.03)
Non-skilled	-0.14	-0.10
	(-0.34 - 0.05)	(-0.20 - 0.00)
Homemaker		0.03
		(-0.03 - 0.10)

Table 7. Results of estimation of first-stage analyses (Continued)

Endogenous variable: Upward	(1) Men	(2) Wo
Large city residence	-0.07**	-0.0
	(-0.12 to -0.03)	(-0.05 to
Cohort dummy (Ref. 1950-1954)		
Cohort 1955 - 1959	-0.21*	-0.29
	(-0.38 to -0.05)	(-0.44 to
Cohort 1960 - 1964	-0.19*	-0.30
	(-0.35 to -0.02)	(-0.46 to
Cohort 1965 - 1969	-0.44**	-0.52
	(-0.61 to -0.28)	(-0.67 to
Cohort 1970 - 1974	-0.43**	-0.65
	(-0.62 to -0.25)	(-0.82 to
Cohort 1975 – 1979	-0.72**	-0.87
	(-0.96 to -0.47)	(-1.11 to
Cohort 1980 - 1984	-0.70**	-1.01
	(-1.00 to -0.39)	(-1.28 to
Constant	3.66**	3.07
	(2.24 - 5.07)	(1.72 -
Observations	1,712	1,94

a) Numbers are coefficients with 95% confidence intervals in parentheses. ***P* <0.01, **P* <0.05.

Table 8. Self-rated health (binary) and upward mobility by linear probability model (LPM) and instrumental variable (IV) approach [a)]

	Men (n=1,712) (1) LPM	(2) LPM+IV	Women (n=1,945) (3) LPM	(4) LPM+IV
Upward mobility	0.02 [b)] (-0.02 - 0.05)	0.40* (0.06 - 0.74)	-0.02 (-0.05 - 0.02)	0.41 (-0.26 - 1.08)
Durbin-Wu-Hausman endogeneity test	P<0.05*		p= 0.14	
Hansen J statistic	p = 0.07		p = 0.97	
Cragg-Donald Wald F statistic	13.38		3.65	

a) Adjusted by age, occupation, marital status, scale of residential area, and cohort dummy. Full results are available upon request.

b) Numbers are coefficients with 95% confidence intervals in parentheses. ***P* <0.01, **P* <0.05.

Appendix

Table A1. Response rate of SSM

Year	Sample size	Valid response	Response rate
1965 (Only men)	3,000	2,158	71.90%
1975 (Only men)	4,001	2,724	68.10%
1985-A (Only men)	2,030	1,239	61.00%
1985-B (Only men)	2,030	1,234	60.80%
1995-A	4,032	2,653	65.80%
1995-B	4,032	2,704	67.10%
2005	13,031	5,742	44.10%

Table A2. Response rate of JGSS

Year	Sample size [a)]	Valid response	Response rate
2000	4,262	2,766	64.90%
2001	4,182	2,638	63.10%
2002	4,460	2,780	62.30%
2003	6,373	3,279	51.50%
2005	4,002	2,023	50.50%
2006-A	3,554	2,124	59.80%
2006-B	3,560	2,130	59.80%
2008-A	3,538	2,060	58.20%
2008-B	3,566	2,160	60.60%
2010-A	4,032	2,507	62.20%
2010-B	4,017	2,496	62.10%
2012-A	3,943	2,332	59.10%
2012-B	3,972	2,335	58.80%

a) Sample size = [number of random samples] – [number of unsuitable samples]. Unsuitable samples included, for example, unknown address, death, change of location, and exceeding age limit.

Table A3. Results of estimation of first-stage analyses (incomes: deciles)

Endogenous variable: Upward	(1) Men	(2) Women
ln (University advancement rate)	-0.46**	-0.58**
	(-0.81 - -0.11)	(-0.91 - -0.25)
Rural resident in childhood	0.09**	0.03
	(0.04 - 0.14)	(-0.02 - 0.07)
Age	-0.03**	-0.03**
	(-0.03 - -0.02)	(-0.04 - -0.03)
Marital status (Ref. Unmarried)		
Divorce/bereavement	-0.03	-0.13**
	(-0.12 - 0.06)	(-0.21 - -0.05)
Married	0.21**	0.30**
	(0.14 - 0.27)	(0.23 - 0.37)
Occupation (Ref. Professional)		
Executive	0.05	-0.25*
	(-0.11 - 0.21)	(-0.45 - -0.05)
Clerical	-0.00	0.02
	(-0.07 - 0.06)	(-0.04 - 0.08)
Sales	-0.04	0.01
	(-0.11 - 0.04)	(-0.07 - 0.09)
Agriculture	-0.00	-0.07
	(-0.16 - 0.15)	(-0.29 - 0.15)
Skilled	-0.00	-0.06
	(-0.07 - 0.07)	(-0.16 - 0.04)
Semi-skilled	-0.08*	-0.07
	(-0.15 - -0.00)	(-0.15 - 0.01)
Non-skilled	0.01	-0.09
	(-0.25 - 0.27)	(-0.19 - 0.01)
Homemaker		0.03
		(-0.03 - 0.09)

Table A3. Results of estimation of first-stage analyses (Continued, incomes: deciles)

Endogenous variable: Upward	(1) Men	(2) Women
Large city residence	-0.05*	-0.00
	(-0.10 - -0.00)	(-0.05 - 0.04)
Cohort dummy (Ref. 1950-1954)		
Cohort 1955 - 1959	-0.30**	-0.20**
	(-0.43 - -0.16)	(-0.34 - -0.06)
Cohort 1960 - 1964	-0.32**	-0.24**
	(-0.46 - -0.18)	(-0.39 - -0.10)
Cohort 1965 - 1969	-0.58**	-0.48**
	(-0.72 - -0.44)	(-0.62 - -0.34)
Cohort 1970 - 1974	-0.56**	-0.64**
	(-0.73 - -0.40)	(-0.80 - -0.48)
Cohort 1975 – 1979	-0.88**	-0.87**
	(-1.10 - -0.66)	(-1.09 - -0.66)
Cohort 1980 - 1984	-0.93**	-1.00**
	(-1.21 - -0.66)	(-1.25 - -0.75)
Constant	3.44**	4.08**
	(2.21 - 4.67)	(2.93 - 5.24)
Observations	1,712	1,945

a) Numbers are coefficients with 95% confidence intervals in parentheses. ***P* <0.01, **P* <0.05.

Table A4. Self-rated health (binary) and upward mobility by linear probability model (LPM) and instrumental variable (IV) approach (incomes: deciles) [a)]

	Men (n=1,712) (1) LPM	(2) LPM+IV	Women (n=1,945) (3) LPM	(4) LPM+IV
Upward mobility	0.02 [b)] (-0.02 - 0.06)	0.48* (0.06 - 0.90)	-0.01 (-0.04 - 0.03)	0.31 (-0.26 - 0.87)
Durbin-Wu-Hausman endogeneity test	P<0.05*		p= 0.22	
Hansen J statistic	p = 0.08		p = 0.47	
Cragg-Donald Wald F statistic	9.31		4.95	

a) Adjusted by age, occupation, marital status, scale of residential area, and cohort dummy. Full results are available upon request.

b) Numbers are coefficients with 95% confidence intervals in parentheses. ***P* <0.01, **P* <0.05.

Table A5. Self-rated health (ordered) and upward mobility by ordered probit model (OPM) and instrumental variable (IV) approach [a)]

	Men (n=1,712)		Women (n=1,945)	
First stage: Upward	(1) OPM	(2) OPM+IV	(3) OPM	(4) OPM+IV
ln (University advancement rate)		-0.65** (-1.03 to -0.27)		-0.26 (0.16 to -0.62)
Rural resident in childhood		0.10** (0.05 – 0.15)		0.05 (0.01 – 0.09)
Second stage: SRH				
Upward mobility	-0.05 [b)] (-0.16 - 0.06)	-0.99** (-1.74 to -0.24)	0.05 (-0.06 - 0.16)	-1.31* (-2.46 to -0.16)

a) Adjusted by age, occupation, marital status, scale of residential area, and cohort dummy. Full results are available upon request.

b) Numbers are coefficients with 95% confidence intervals in parentheses. ***P* <0.01, **P* <0.05.